PATENT SPECIFICATION

(11) 1355 192

1355 192

(19) THE PATENT OFFICE LONDON

(21) Application No. 60700/70 (22) Filed 21 Dec. 1970
(23) Complete Specification Filed 3 Dec. 1971
(44) Complete Specification published 5 June 1974
(51) International Classification B01J 2/00//A23C 9/00 A23F 1/00 A23P 1/00
(52) Index at acceptance
B5A 1L
A2E 4

(72) Inventors KARL ERIK HANSEN and OVE HANSEN

(54) IMPROVEMENTS IN OR RELATING TO METHODS FOR PRODUCING AGGLOMERATED COFFEE POWDER AND OTHER POWDERS AND APPARATUS FOR CARRYING OUT THE METHOD

(71) We, AKTIESELSKABET NIRO ATOMIZER, a Company organized under the laws of Denmark, of 305, Gladsaxevej, 2860 Søborg, Denmark, do hereby declare the invention, for which we pray that a Patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a method of agglomerating a powder of a type which becomes adhesive when moistened; powders of this type include, for example, coffee powder, fat-enriched milk powder, baby-food powder, skimmed milk powder, soup powder and mashed potato powder. The invention also relates to an apparatus for performing the method.

The agglomerated powder has to meet the requirement of being able to resist the mechanical effects it will normally be subjected to during packing and when being transported and, at the same time, the agglomerated powder has to, when poured into water, be quickly separated into the original particles so that a rapid dissolution may be obtained.

The principle of agglomerating powders consists in that individual grains of powder are rendered adhesive on their surfaces and are made to collide with each other so that they come to adhere together in bigger or smaller agglomerates. The surfaces can be rendered adhesive either by means of an adhesive agent or by a superficial moistening in such a way that a thin surface layer is dissolved and becomes adhesive. When legislation prohibits foreign substances to be introduced, only the latter method may be available.

While it is possible to moisten certain powders, as, for instance, skimmed milk powder, without any difficulty in order to form an adhesive surface layer, this is connected with great difficulties with other powders. This applies, for example, to coffee powder, since the individual grain of powder has a tendency to rapidly absorb moisture so that the total solid matter content or, at any rate, the greater part thereof is dissolved so that the grains, when colliding with each other, acquire a tendency to coalesce instead of merely superficially stick together as is necessary for forming the desired agglomerates.

A method of the kind dealt with above is known, in which the powder drops down on to a rotating disc, while water is being sprayed in an area along the circumference of the disc and, in part, outside same through a plurality of nozzles which are distributed along the circumference. Consequently, the powder will, in a dry state, move outwards along the surface of the disc to the sprayed area where the powder is rapidly moistened before subsequently being flung out over the edge to an area in which moisture is also supplied. This method is not suitable when it is a question of coffee powder or other powders possessing corresponding properties with a view to the formation of agglomerates, but it has been developed for use in the production of such products as soup powders, powdered mashed potato and other powders having corresponding properties.

The invention provides a method of agglomerating a powder of a type which becomes adhesive when moistened, wherein the powder is made to drop on to a rotating disc by the rotation of which the powder is led towards the circumference of the disc and drops down through a chamber in which a separation of unagglomerated powder takes place and from which the agglomerated powder goes into a dryer, and wherein the dry powder is made to fall down towards a central area of the disc and the moistening takes place by the supply of steam or finely

atomized liquid over a central area of the disc at such a distance above the same that substantially all the powder is moistened before it hits the disc.

Preferably, the powder is supplied in such a way that it is uniformly distributed across the cross-section of the moistening zone. The quantity of powder supplied per unit of area of the disc may be from 2 to 22 kg/m²sec., preferably 10 to 15 kg/m²sec. Water may be used as the moistening agent, and the water may be heated prior to being supplied. Instead of water, however, a liquid having a solid matter content of the same material as that of which the powder consists, may be used.

Thus the powder drops on to the central portion of the disc immediately after having been moistened or on to a quantity of powder accumulated on this central portion which in some cases may build up into a cone-like cake, whereby it has to be assumed, the agglomerates are formed at so early a moment that the liquid has not yet succeeded in being absorbed into the inside of the individual grains of powder. From this central part, the powder is flung outwards towards the circumference of the disc in an agglomerated form, whereupon the agglomerate is flung into the dryer. The fine, unagglomerated powder which is separated in the chamber is conducted back for processing while the agglomerates are conducted from the dryer to be packaged and dispatched. It is also possible to separate unagglomerated powder particles from the dryer and the succeeding transport system which are likewise returned for processing.

The disc is suitably rotated at a speed between 200 and 3000 rpm, preferably 600 to 1300 rpm, and the rotating disc does to some extent act as a centrifugal blower, so that a vacuum is created around the axis of rotation of the disc. This vacuum results in a constriction of the falling mass of powder, so that the powder hits the disc in a fairly concentrated central area, which appears to be of great significance for obtaining the desired result.

As a consequence of the collision of the particles taking place immediately upon moistening, the formation of the agglomerates occurs even before the volume of liquid supplied has been able to manage to disperse inside the individual particles. This has as a result that only an insignificant amount of liquid has to be supplied, that is to say, just enough for moistening the surface, so that same is sticky when the collisions occur, but immediately afterwards, the moisture is going to disperse rapidly due to the properties of the powder which, on account of the small amount of liquid involved results in a rapid solidification of the surface layer and, thereby, in a very stable binding together of the particles in the agglomerates formed.

The invention also provides an apparatus for carrying out the method according to the invention, which apparatus comprises a chamber having, at the top, a powder inlet and an inlet for atomised liquid and/or steam and a rotatable disc mounted below the powder inlet, the axis of rotation of said disc coinciding with the axis of the chamber, and wherein the powder inlet comprises a tube terminating above an area which includes a central area of the disc and mounted parallel to the axial direction of the chamber, and wherein the inlet for the liquid or steam is constituted by one or several nozzles mounted in or in the proximity of the mouth of the tube on the axis of the tube.

With such an apparatus particularly satisfactory results are obtained, which are obviously due to the fact that by regulating the volume of liquid supplied in relation to the quantity of powder and the number of revolutions of the disc, it is possible to attain the best conditions possible for the desired agglomerate formation.

In the following, the invention is explained in greater detail with reference to the accompanying drawings, in which:—

Figure 1 shows a diagram of a plant for carrying out the method according to the invention, and

Figure 2 shows a detail of the apparatus according to the invention seen in section.

In Figure 1, 1 designates a chamber with a rotating disc 2, on to which powder drops which is introduced via a funnel 3 that continues in a tube 4. The powder during its drop is moistened by means of liquid or vapour e.g. steam which is supplied via a tube 5 above a central area of the disc 2. The powder is fed into the funnel 3 from a silo 9 with the aid of a vibrating chute 10 The powder is flung off the disc 2 in an agglomerated state and drops down through the chamber, which is open at the top, in such a way that air is drawn in which is imparted a rotating movement by the disc.

In the chamber 1, a separation of fine, unagglomerated particles takes place which are drawn off by suction with air that is absorbed via a tube 7 which terminates axially in chamber 1 and which is screened off against the dropping powder.

The air is led via tube 7 to a cyclone 8, in which the fine powder is separated and drops into the silo 9. The air is drawn off from the cyclone 8 by means of a blower 11.

The lowermost part 12 of the chamber 1 is displaceable in relation to the other part of the chamber, with which it communicates by means of a pliant sleeve 13. This part 12 comprises a vibrating sieve 14, by means of which remaining amounts of fine particles are separated and conducted via a transport line 15 to an additional transport line 16 which leads the fine powder up to cyclone 8.

The sieve 14 is by way of example, a combined sieve comprising a coarse sieve of a mesh width of 16 mms and a fine sieve of a mesh width of 500μ to 1500μ.

In the lowermost part of the chamber, a certain volume of air is introduced by means of a blower 17 and, for a suitable heating of this volume of air, a heating unit 18 is inserted in conjunction with the blower 17 and the chamber 1.

The agglomerated particles that are sifted off proceed via a line 19 to a dryer 20 of a known type, where the agglomerated powder is moved in a fluidised state on to a vibrating table which is divided into sections and through which hot air is blown in three different steps via lines 21, which are connected with the blower 23 via heating units 22.

The powder leaves from exit 24 of the dryer 20, which exit may be connected to a suitable conveyor to a packing station. Before the exit 24, a vibrating sieve is inserted for sifting off the finer powder, which is also fed into line 16.

The air discharged from the dryer 20 is led via a line 25 to a cyclone 26, in which any powder that might have been carried along is separated and drops, via a line 27, down into the transport line 16. To this line, moreover, a blower 28 is connected for producing the requisite transporting air.

The humid air leaves the cyclone 26 to an air exit 29, in which a blower 30 is inserted.

Figure 2 shows an embodiment of the upper part of the chamber 1 with the disc 2, which is mounted with its axis of rotation axially in the chamber and which is driven by a motor 40, which is likewise mounted in the axis of the chamber and which is borne by carrying means 41 which are connected to the wall of the chamber 1.

In a central position relative to the mouth of the tube 4 above the central area of the disc 2 there is provided one or more nozzles 42. The nozzle or nozzles are preferably multi-fluid nozzles with an inlet duct for the moistening agent and an inlet duct for an atomising agent such as air or vapour or a mixture thereof. In the embodiment shown, a nozzle 42 is mounted with an inlet tube 43 for liquid and a compressed air line 44. The nozzle can suitably be mounted outside the mouth of the tube 4 or at such distance inside the tube, that the atomising cone of the nozzle just avoids touching the rim of the tube.

The principle of the agglomeration process is that the powder, on its way from the mouth of tube 4 to the disc 2, is superficially moistened by means of the finely dispersed liquid issuing sprayed by nozzle 42 and that by colliding with the central part of the disc, where already previously powder particles have lodged themselves, it forms agglomerates that are flung off the disc on account of its rotation and drop down through chamber 1.

In order to achieve a uniform moistening, the powder particles will have to be uniformly distributed across the cross-section of the mouth of the tube, which it is possible to achieve by adjusting the vibrating chute 10 in Figure 1.

The length of the tube 4 is sufficient that the powder falling through the tube attains a substantially uniform distribution at the level of the nozzle 42. Said length depends particularly upon the type and size of the powder particles to be agglomerated and can be determined experimentally. During the fall of the powder particles from the region around the nozzle towards the disc 2 the falling velocity of the particles is further increased owing to the ejector effect of the nozzle 42 and the vacuum created around the centre of the disc due to its rotation. It is possible thereby to achieve that the particles, by an adequate supply of liquid, are sufficiently moistened on the surface while on their way from the mouth of tube 4 to the disc for the agglomeration to be able to take place, while, at the same time, the liquid supplied is unable to penetrate to any great extent into the powder particles due to the short time required by the dropping powder particles for covering the way from the moment when they are moistened to hitting the disc.

It is thus only necessary to supply the volume of liquid adequate for obtaining the requisite surface adhesiveness and the individual particles retain their nature of solid matter a very short distance below the surface, so that by means of the collisions agglomerates having the desired properties are obtained, that is to say agglomerates in which the individual grains still appear clearly distinct without any disadvantageous coalescence, in that they are only superficially stuck together.

Subsequent to the collision, of course, the liquid is going to disperse from the surface into the inside of the particles, but on account of the very insignificant amount of liquid involved, no softening will be produced thereby, but, on the contrary, a solidification of the surface, because the liquid content of same is greatly reduced by the dispersion of the liquid in the particle. During the operation, a flat cone of material may build up on the central area of the disc since the speed of rotation in the proximity of the axis is very low. The greater part of the particles will, however, continue to move outwards with increasing speed to be replaced by new ones, and it seems as if it is, to a significant degree, the collision between these particles and the succeeding falling particles which gives rise to the agglomerate formation.

The diameter of the mouth of tube 4 must, at the most, be equal to the diameter of the disc since the falling particles have to perforce

hit the disc and in practice it should not be much more than half the diameter of the disc. The diameter of the disc may be 1 to 10 times that of the single tube 4, preferably about 3 times the diameter of the tube.

On their way from the mouth of tube 4 to the disc, the powder particles will tend to be spread on account of the air or vapour originating from the nozzle. This tendency is counteracted and eliminated due to the rotation of the disc, by means of which an air vortex is produced, in that the air is drawn in by suction to the axial area of the disc due to the fan effect produced by the rotation of the disc. Thereby, the volume of the mass of falling powder takes substantially the form of a hyperboloid so that all the powder hits a central area of the disc.

If desired, the fan effect may be increased by providing radial ribs on the upper side of the disc.

The distance from the mouth of the tube 4 to the disc 2 has to be sufficient for all the powder being able to be moistened. This distance has to be in the range of between 1 and 10 times, preferably between 4 and 7 times the diameter of the tube, and in order to be able to easily set this distance to the most favourable value, tube 4, in the construction shown is telescopic.

The disc 2, in the construction shown, is plane, which, as a rule, yields the best result when producing agglomerated coffee powder, while a flattened conical shape with an upwards facing point, or another convexity of the disc facing the tube is often to be preferred when processing fat-enriched milk powder or baby-food powder.

A polytetrafluoroethylene coating on the disc often has a favourable effect towards avoiding undesirable deposits.

In the production of agglomerated coffee powder, a coffee powder having a bulk density, poured, of 0.14 to 0.16 g/cm³ and a water content of 2% to 4% by weight is expediently used as starting material.

Water at ambient temperature may be used for the moistening. The water may possibly be heated, whereby it is possible to use a smaller volume of water for moistening and to reduce the drying period in the drier.

Instead of water, it is possible to use an aqueous coffee extract, preferably an aromatised extract, that is to say an extract of high quality as regarding taste produced either by low yield extraction, by means of which a high content of valuable aromatic substances is obtained, or by adding aroma to an extract. The extract may have a solid matter content of 10% to 50%.

Moistening is carried out to 6% to 12% water content by weight, preferably to 7.5% to 11%. By using an extract instead of pure water, a correspondingly larger volume is used in order to obtain the same volume of water.

In the production of agglomerated fat enriched milk powder or baby-food powder, preferably the liquid is supplied in such a volume that the powder is moistened to a moisture content of 6% to 13% by weight, preferably 8% to 10%.

Example

A plant as shown in the drawing was used.

The diameter of the supply tube was 15 cm.

The diameter of the disc was 50 cm and it rotated at 700 rpm.

The distance from the supply tube to the disc was 80 cm and from the nozzle to the disc 85 cm.

A multi-fluid nozzle having an aperture of 1.2 mm and an angle of spread of 20°—30° was employed. Air was used for the atomisation, water at ambient temperature was used as the moistening agent and it was supplied at the rate of 50 kg/h.

The sieve 13 consisted of a circular, rotating double sieve having a coarse sieve at the top with a mesh width of 16 mm and a fine sieve at the bottom with a mesh width of 800μ (microns).

A spray-dried coffee powder having a water content of 2.8% by weight and a bulk density, when poured, of 0.150 g/cm, was used as starting material.

200 kg/h of coffee powder were supplied to the plant and the quantity of powder recycled to the dryer amounted to approximately 130 kg/h. Drying air at 50°C was supplied to the sieve. Drying air at 75°C, 82°C and 30°C, respectively, was supplied to the three sections of the dryer.

The water content of the moistened coffee powder was 8.9% by weight. Powder was produced in approximately the same quantity as the powder which was supplied, in that the water content of the final product was 3.5% by weight and an oversize-fraction of 5.0 kg/h was sifted off with a sieve having a mesh-width of 3.5 mm.

The bulk density, poured, of the finished product was 0.195 g/cm³ and its sieve analysis was as stated below:

>2000μ	21.1%
1000—2000μ	44.1%
800—1000μ	13.9%
500— 800μ	18.6%
<500μ	2.3%

Mean particle size: 1220μ.

WHAT WE CLAIM IS:—

1. A method of agglomerating a powder of a type which becomes adhesive when moistened, wherein the powder is made to drop on to a rotating disc by the rotation of which the powder is led towards the circum-

ference of the disc and drops down through a chamber in which a separation of unagglomerated powder takes place and from which the agglomerated powder goes into a dryer, and wherein the dry powder is made to fall down towards a central area of the disc and the moistening takes place by the supply of steam or finely atomized liquid over a central area of the disc at such a distance above the same that substantially all the powder is moistened before it hits the disc.

2. A method as claimed in Claim 1, wherein the powder is supplied in such a way that it is uniformly distributed across the cross-section of the moistening zone.

3. A method as claimed in Claim 1 or Claim 2, wherein the moistening agent is water.

4. A method as claimed in Claim 3, wherein the water is heated prior to being supplied.

5. A method as claimed in Claim 3 or Claim 4, wherein the moistening agent is a liquid having a solid matter content of the same material as that of which the powder consists.

6. A method as claimed in Claim 5 for producing agglomerated coffee powder, wherein the moistening agent is an aqueous coffee extract.

7. A method as claimed in Claim 6, wherein the extract has a high aroma content.

8. A method as claimed in Claim 6 or Claim 7, wherein the extract has a solid matter content of 10% to 50%.

9. A method as claimed in any one of the preceding claims for producing agglomerated coffee powder, wherein the moistening agent is a liquid supplied in such quantity that the powder is moistened to a moisture content of 6 to 12% by weight, preferably 7.5 to 11%.

10. A method as claimed in any one of Claims 1 to 5 for producing agglomerated fat-enriched milk powder or baby-food powder, wherein the moistening agent is a liquid supplied in such quantity that the powder is moistened to a moisture content of 6 to 13% by weight, preferably 8 to 10%.

11. A method as claimed in any one of the preceding claims, wherein the disc is rotated at a speed of 200 to 3000 rpm, preferably 600 to 1300 rpm.

12. A method as claimed in any one of the preceding claims, wherein the quantity of powder supplied per unit of area of the disc is from 2 to 22 kg/m^{2}sec, preferably 10 to 15 kg/m^2 sec.

13. An apparatus for carrying out the method as claimed in any one of the preceding claims comprising a chamber having, at the top, a powder inlet and an inlet for atomised liquid and/or steam and a powder exit at the bottom, as well as a rotatable disc mounted below the powder inlet, the axis of rotation of which coincides with the axis of the chamber, wherein the powder inlet comprises a tube terminating above an area which includes a central area of the disc and mounted parallel to the axial direction of the chamber, and wherein the inlet for the liquid or steam is constituted by one or several nozzles mounted in or in the proximity of the mouth of the tube on the axis of the tube.

14. Apparatus as claimed in Claim 13 wherein the disc is provided with radial ribs on its upper side.

15. An apparatus as claimed in Claim 13 or 14, wherein the nozzle or nozzles are multi-fluid nozzles with an inlet duct for the moistening agent and an inlet duct for an atomising agent such as air or vapour or a mixture thereof.

16. An apparatus as claimed in Claim 13, 14 or 15, wherein the diameter of the disc is from 1 to 10 times that of the tube for supplying the powder, preferably about 3 times the diameter of the tube.

17. An apparatus as claimed in Claim 16, wherein the distance from the mouth of the tube to the disc is from 1 to 10 times as great as the diameter of the tube, preferably 4 to 7 times as great.

18. An apparatus as claimed in Claim 16 or 17, wherein the nozzle is mounted at such distance inside the tube that the atomising cone of the nozzle just avoids touching the rim of the tube.

19. An apparatus as claimed in any one of Claim 13 to 18 for use in the production of agglomerated coffee powder, wherein the disc is planar.

20. An apparatus as claimed in any one of claims 13 to 18 for use in the production of fat-enriched milk powder, wherein the disc has a convexity facing the mouth of the tube, preferably a flattened conical shape.

21. An apparatus as claimed in any one of Claims 13 to 20, wherein the disc is provided with a coating of polytetrafluoroethylene.

22. An apparatus as claimed in any one of claims 13 to 21, wherein the tube is telescopic for adjustment of the distance of its mouth from the disc.

23. An apparatus as claimed in any one of Claims 13 to 22, wherein the length of the tube is such that the powder falls a sufficient distance in the tube to attain a substantially uniform distribution at the level of the nozzle.

24. A method of agglomerating powder according to Claim 1 and substantially as herein described.

25. An apparatus for the production of agglomerated powders substantially as herein described with reference to the accompanying drawings.

STEVENS, HEWLETT & PERKINS,
Chartered Patent Agents,
5 Quality Court,
Chancery Lane,
London, WC2A 1HZ.
Agents for the Applicants.

Printed for Her Majesty's Stationery Office, by the Courier Press, Leamington Spa, 1974.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

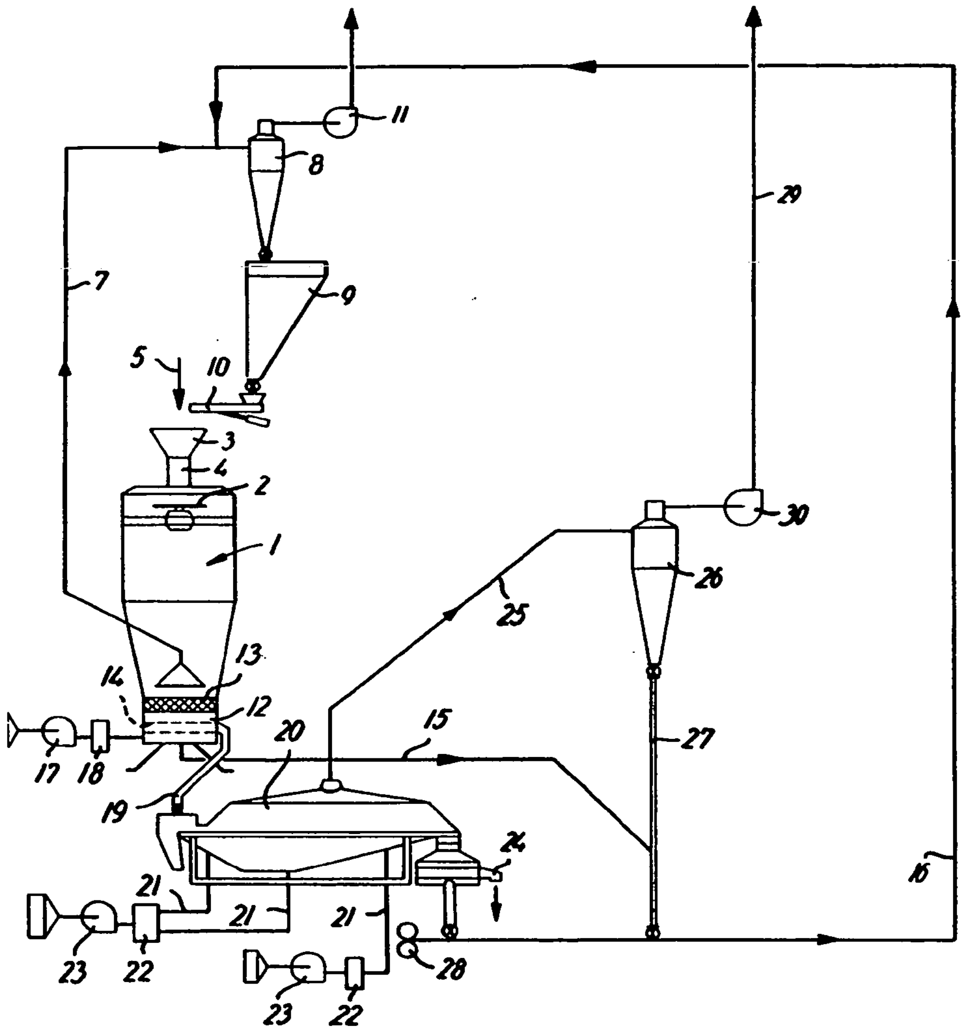
11
8
7
29
9
5
10
3
4
2
1
30
26
25
13
14
12
20
15
27
17
18
19
24
16
21
21
21
23
22
28
23
22

FIG. 1

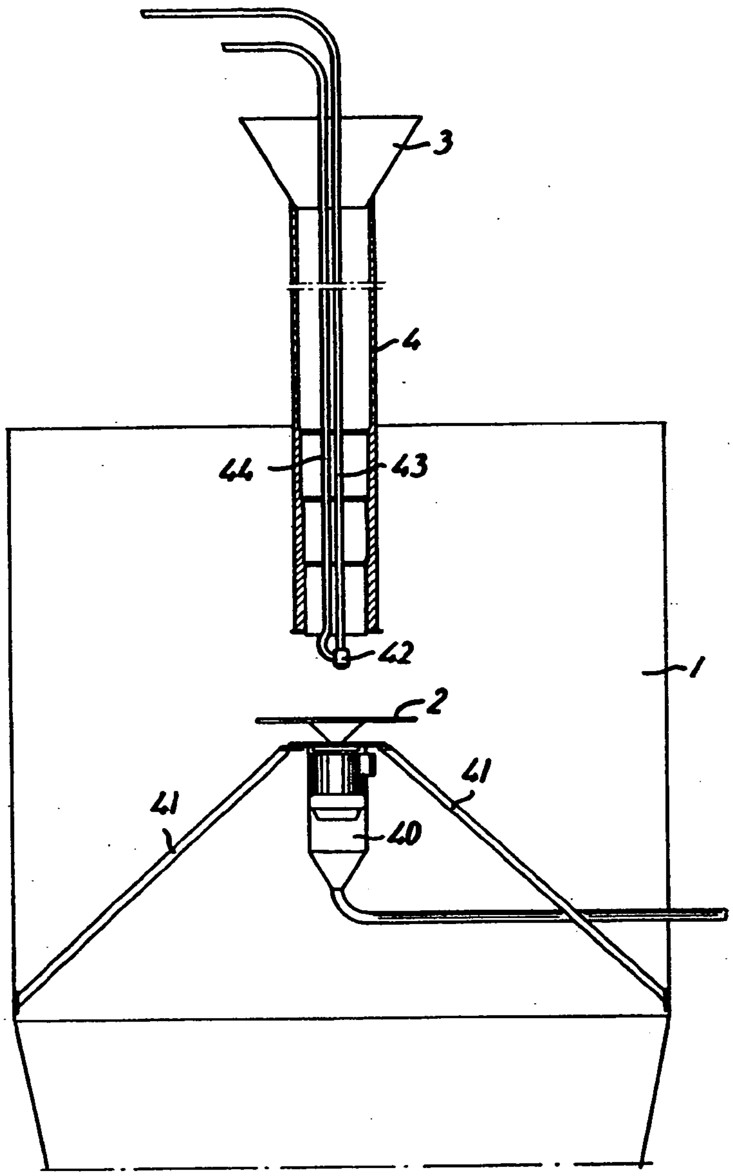

FIG. 2